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DIET STRESS EFFECT ON ADAPTIVE STRATEGY OF BLACK BUPRESTIDAE *CAPNODIS TENEBRIONIS* (COLEOPTERAN: BUPRESDAE) TRANSLATED BY ITS ENERGY-GIVING ALLOTMENTS FLUCTUATIONS

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ABSTRACT

In trees with stones, ***Capnodis tenebrionis*** appears among major depredators and the most dangerous, but the most mysterious too because of its resistance facing all phytosanitary treatments and so of its biological cycle enough confused going from 1 to 2 years. Present study is performed in the centre of Atlas Tellien in region of Medea. Zone of potential production of rosaceous with stones on plums trees' orchards (*Prunus domestica*) and cherry trees (*Prunus mahaleb*) seriously infested by *Capnodis tenebrionis* Our vestigations had been spread on 3 seasons (winter, spring, summer), with aim to grasp relation which may exist between nourishing support and biological performance of *Capnodis tenebrionis*.

This trophic relation is estimated through energetic results of Capnodis individuals moving around on different hosts. Results had been significant in term of phytochemical quality variability of both studied hosts. Relation between variation of leaf limbus and petioles' composition and so *Capnodis* females numerical and ponderal evolution has been considered. Variations of total sugars contents and condensed tannins during seasonal variation have been observed. Those modifications affect females' energetic result Abundance of *Capnodis* individuals on *Prunus domestica* is linked to total sugars quantities, whereas on *Prunus mahaleb*, it would be linked to condensed tannins.

KEYWORDS: Lipidic Reserves, Carbohydrate Reserves, Rosaceous with Stones, Total Sugars, Condensed Tannins, Stress

INTRODUCTION

Insufficiency from which suffer rosaceous sectors are being worse by troubles linked to technical, managerial and climatic constraints, for that reason, parasitic attacks may be numerous, recurred and very damageable (Mahhou, 2009). *Capnodis tenebrionis* L. (1758) is known in several regions of Mediterranean basin as phytophage insect common to rosaceous family. Damages committed by adults are clearly distinguished from those inflicted by larvae; those last ones cause almost invariably death of attacked individual. Whereas adults partly defoliate attacked individuals and especially devouring petioles, destroying buds and shelling in surface, hardly harvested tender growth or weakly lignified (Gouguenheim *et al*., 1950).

Trophic relation between devastating insect and host plant allowing minimal contribution in required diet for survival and growing is mainly based on temporal availability of biochemical composition of attacked organs. Synchronisation degree between infecting insect's stage and stages of phonologic vulnerable is going beyond of the simple

availability of the food but essentially to its quality (Mopper, 2005 ; Barat, 2007; Lichou *et al*., 2009).In this way, larval development and metamorphose are also expensive steps in terms of energy (Harvey, 1974).

However not much studies were interested to larvae Capnodis diet requirement notably this one of Gindin *et al.* (2009). In this way, chemical compounds adjusting adults' development are not too much documented. Furthermore, no research is opened on evolution of those contributions in terms of energetic allotments. In this context, present study is aiming to perfect on diet preferences of Capnodis female's adults between limbus and petiole in *Prunus domestica* and *Prunus mahaleb* in terms of total sugars and condensed tannins. Study aims to focus on impact of nourishing contribution on energetic reserves' allotments of *Capnodis* females.

MATERIALS AND METHODS

General Frame of Studied Region

Present study is performed in centre of Atlas Tellien in Ben Chicao region (Medea) at 1.200 meters altitude. It is situated at 2° 51' longitude East and 36° latitude North, characterized by larges lines' slopes and crests forming so, several depressions (Skender, 1978) Index of Emberger classifies zone of Medea in bioclimatic stage sub-damp with cool winter and average rain-gauge between 400 to 500 mm. Study site is a spot called Haouch Chanas, two plots have been chosen by chance among 6 units divided according ground nature respectfully consisting of plantation of *Prunus domestica* and plantation of *Prunus mahaleb*, respectfully of 5 and 7 years.

Sampling Technique

Biological material intended to our trial has been limited to *Capnodis* adults besides vegetable organ samples aimed by insect, represented by both foliar compartments (leaf limbus and petiole). Linear system with observation platforms proposed by Frontier (1983), has been adopted. Samplings have been realised by chance on trees partially or totally mined containing extern symptoms warning presence of capnode. Investigations have been spread from July 2009 to February 2010 that is to say 16 outgoings on the ground with total of 128 trees prospected. Sampled animal material during each outgoing is sorted out and weighted, then kept at -20°c for further dosage of energetic reserves. Sampled vegetable material is kept at -20°C for extraction and dosage of total sugars and condensed tannins.

Calculation of Numerical and Ponderal Growing of *Capnodis* Individuals

After enumeration of Capnodis' adults identification between females and males has been realised in laboratory under stereoscopic microscope. Ponderal measures of *Capnodis* females have been, realised by an exactness balance (Princeton instruments Model YR4O2N).

Extraction and Dosage of Energetic Reserves

From sampled *Capnodis* females' individuals on both hosts plants, we have quantify lipidic biomarkers and carbohydrate biomarkers. Extraction and quantification of lipidic reserves have been performed according to method of Van Brummelen & Suijfzand (1993). Extraction is made from cold-mashed of *Capnodis* individuals by monophasic mixture 1: 2: 0, 8 (chloroform: methanol: water bi-distilled). Tubes are centrifuged during 5 minutes at (14772 tr/mn) Adding chloroform in tubes induces mixture separation in two phases, Chloroform solutions containing lipids are recovered and put together, then dried on sodium sulphate. Lipids are recovered after rinsing of sodium sulphate with chloroform. Tubes are put to be evaporated in dry-state under nitrogen flux. Sulphuric acid is added to dried residue then,

heated during 10 mn at 100°C. After cooling, vanillin reactive is added in each sample. Solution takes pink colour, and we read optic density at 540 mn from 10 minutes. White is obtained from series of cholesterol concentrations mixed to sulphuric acid and to vanillin reactive.

As for extraction and quantification of carbohydrate reserves, we have been helped by method of Win Decoen (2000). Mashed of *Capnodis* individuals' sample is homogenised in bi-distilled water with grinder, then of trichloroacetic acid (TCA 15%) is added in order to make throwing down proteins. Precipitation is made easier by centrifugation during 10 mn at 3000 rmp at 4°C. Remained afloat containing sugars is collected and base is dissolved again in solution of TCA 5% 250 µl of solution containing over floating are poured in try tube of which are added quickly 250 µl of phenol 5% and 1 ml of H_2SO_4.. This mixture is put down in micro plaque well in light and in ambient temperature. Samples absorption is measured after 30 mn at 490 nm. White is obtained from mother solution of glucose at 0.5mg/ml (5 mg of glucose in 10 ml of distilled water).

Extraction and Dosages of Chemical Compounds

From sampled petioles and limbus on both host plants, we have quantified total sugars and condensed tannins. Total soluble sugars are dosed by method of Dubois *et al.* (1956). Vegetable matter is put in contact with ethanol at 80% during 48 hours. Ethanol solution is evaporated at hot. Dry residue obtained is added to phenol mixture at 5% and of concentrated sulphuric acid. After immersion in bain-marie, lecture of optic density will be done at 485 nm after 10 mn.

Extraction and dosage of condensed tannins have been realised by method of Price *et al*. (1978). Double extraction is realised by acetone mixture and distilled water (7:3) and vegetable powder finely crushed. Obtained filtrate is evaporated under pressure reduced until desiccation. Dry residues are moistened by 5 ml of hot methanol. Mixture of methanolic tannins and vanillin-Hcl (1:5) solution is heated in bain-marie during 20 mn at 30°C, and then absorbance is read at 535 nm. White is obtained from concentrations series of catechol mixed with distilled water (1mg/ml).

Data Analysis

In case of several factors possibly being implied in variation of quantitative variable, general linear model (G.L.M) has been chosen among several ANOVA in order to maintain higher degree of liberty. All these tests have been performed with SYSTAT 12 (Systat Software inc., 2007)

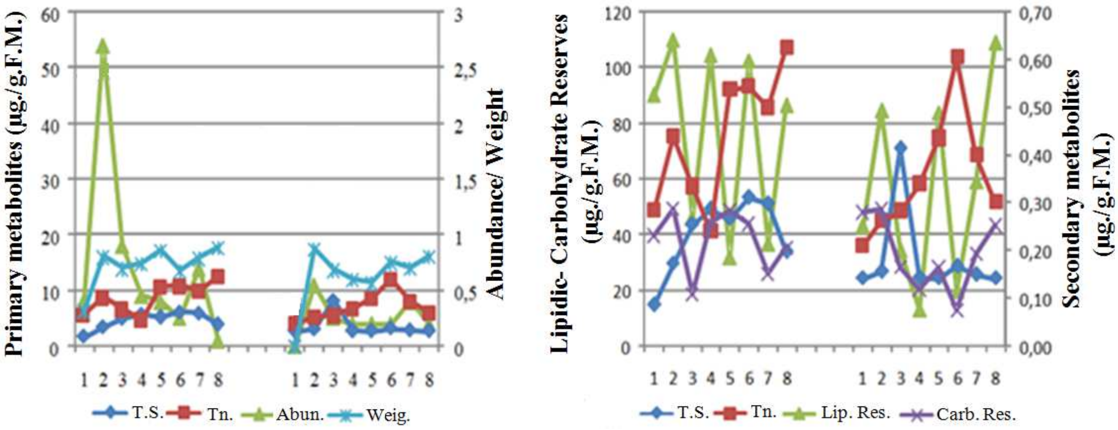
Importance of correlations between two variable sharing normal distribution has been tested from associated probability to coefficient of Pearson r. Calculations have been performed with help of PAST 2.11 software (Hammer *et al*., 2001). Analyses have been applied to biochemical compounds and to metabolic markers in order to visualize links between nourishing support and translation of energetic allotments.

RESULTS

Temporal Evolution of Conditioning and Metabolic Parameters of Female's Adults *Capnodis* in Function of Phytochemical Quality of *Prunus domestica* and *Prunus mahaleb*

We have studied numerical fluctuations of capnode adults moving around on *Prunus* gender. Enumeration has reached 116 females and 189 males along of the three seasons (spring, summer, winter). Global distribution of capnode' individuals' shows numerical and ponderal evolution more important on *Prunus domestica* presenting progressive evolution of total sugars concentration compared with *Prunus mahaleb* which displays concentrations also weaker in

mi-summer. During this last phase, condensed tannins display progression in both species of *Prunus*. As for lipidic- carbohydrate reserves quantities, they show very variable fluctuations between both host species, with hegemony for lipids (figure 1).

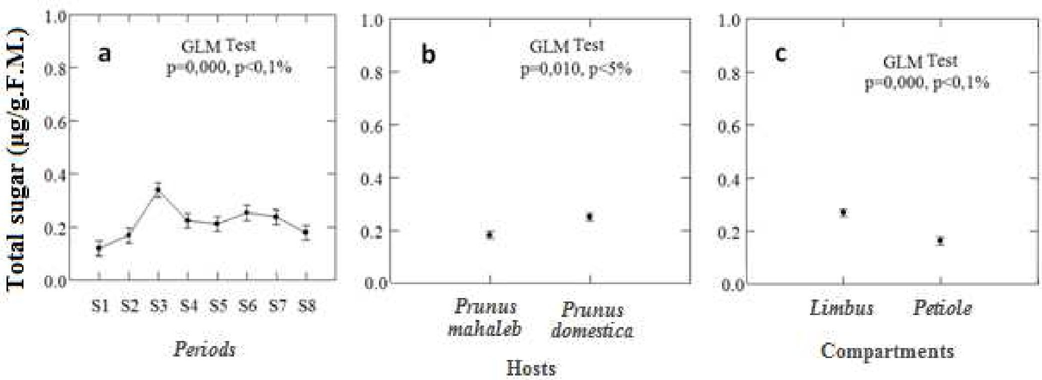


T.S.: Total Sugars **Tn:** Condensed tannins, **Abun:** Females Abundance *Capnodis*, **Weig:** Females Weight *Capnodis*, **Lip. Res**: Lipidic Reserves, **Carb. Res.:** Carbohydrate Reserves, 1=mi-Spring, 2= Spring End, 3= Summer Start, 5 and S4 = mi-Summer, 6= Summer End, 7= Winter Start, 8= mi-Winter

Figure 1: Temporal Evolution of Phytochemical Molecules Rates of *Prunus* and Parameters of Conditioning and Metabolic of Females Adults *Capnodis*

Study Compared to Temporal Variation of Total Sugars and Condensed Tannins between *Prunus domestica* and *Prunus mahaleb*

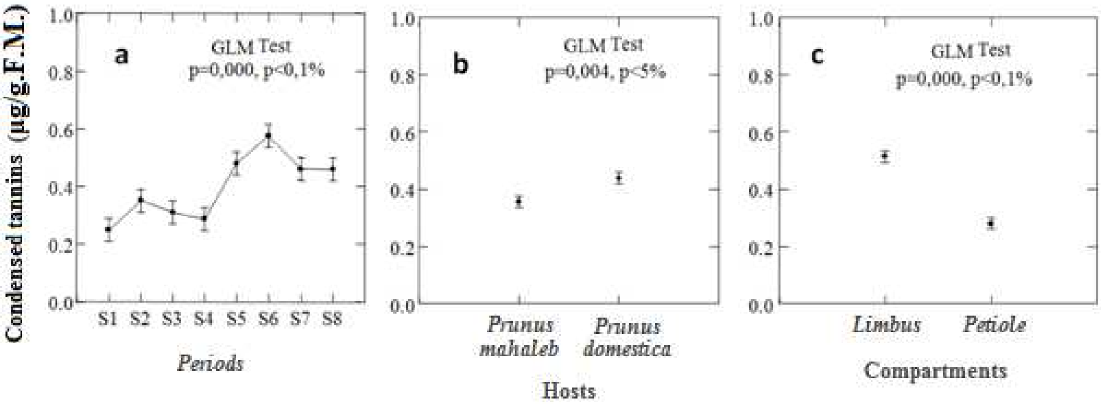
We have applied general linear model **(**G.L.M), in order to study quantitative difference of total sugars and condensed tannins between both host species of *Prunus* along of three studied seasons. Analyse results of variance, clearly show that total sugars vary with significant manner in the time, with higher rates in summer (Figure 2a) and with upper concentrations for *Prunus domestica* compared to *Prunus mahaleb* (Figure 2b). It is also interesting to report that total sugars quantities differ very significantly between limbus and petiole, with quantities more important to limbus (Figure 2c).



S1= mi-Spring, S2=End Spring, S3=Start Summer, S5andS4=mi-Summer, S6=End Summer, S7=Start Winter, S8=mi-Winter

Figure 2: Compared Study of Total Sugars Fluctuations in Periods Function, of Host's Species and of Compartments

Results concerning quantification of condensed tannins show a clear significant temporal difference (Figure 3a) furthermore, results display significant effect of the plant, with visible success of *Prunus domestica* compared to *Prunus mahaleb* (Figure 3b).This quantitative difference is also translated between compartments where most important quantities display at limbus level (Figure 3c).

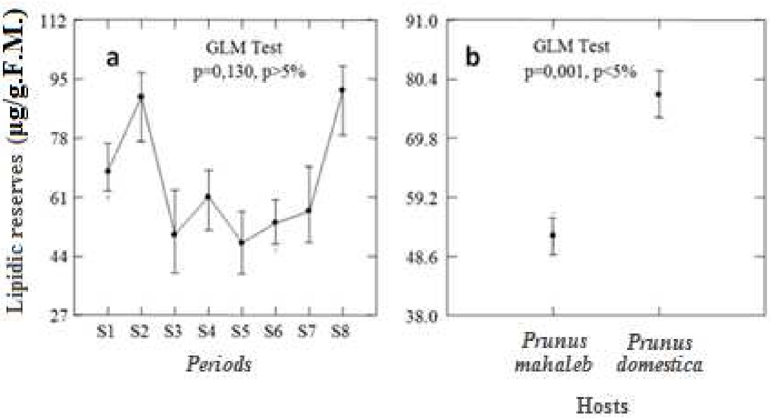


S1= mi-Spring, S2= End Spring, S3= Start Summer, S5 and S4= mi-Summer, S6= End Summer S7= Start Winter, S8= mi-Winter

Figure 3: Compared Study of Condensed Tannins Fluctuation in Function of Periods, of Host's Species and of Compartments

Influence of Nourishing Support on Lipidic Reserves

Graphic representation of variance analysis GLM type, expresses quantitative variation highly significant of *Capnodis* females lipidic reserves under nourishing support influence which inclines towards plum-tree (Figure 4b). Contrary to seasonal variability of energetic allotments which is no significant (Figure 4a), in spite of apparent fluctuations in beginning of spring and at the end of winter.



S1=mi-Spring, S2= End Spring, S3= Start Summer, S5 and S4= mi Summer, S6=End Summer, S7=Start Winter, S8= mi-Winter

Figure 4: Compared Study of Lipidic Reserves Fluctuations in Function of Periods and of Hosts Species

Hosts Plants' Effect on Parameters Interactions of *Capnodis* Females Conditioning and Metabolic / Phytochemical Quality of *Prunus domestica* and *Prunus mahaleb*

Gross data relating to phytochemical quality of *Prunus domestica* and *Prunus mahaleb* and so energetic result

(lipidic/ carbohydrate reserves) have been submitted to correlation analysis in order to appreciate further relations between nourishing support and energetic allotment. Comparison of numerical variables is requested in order to calculate correlation coefficient of Pearson r and so associated probabilities

To visualize strong relations of different parameters, we have established following diagrams (Figure 5). Arrows show relations between variables whereas coefficient values show correlation nature, on the other hand, probabilities show correlation of the strength.

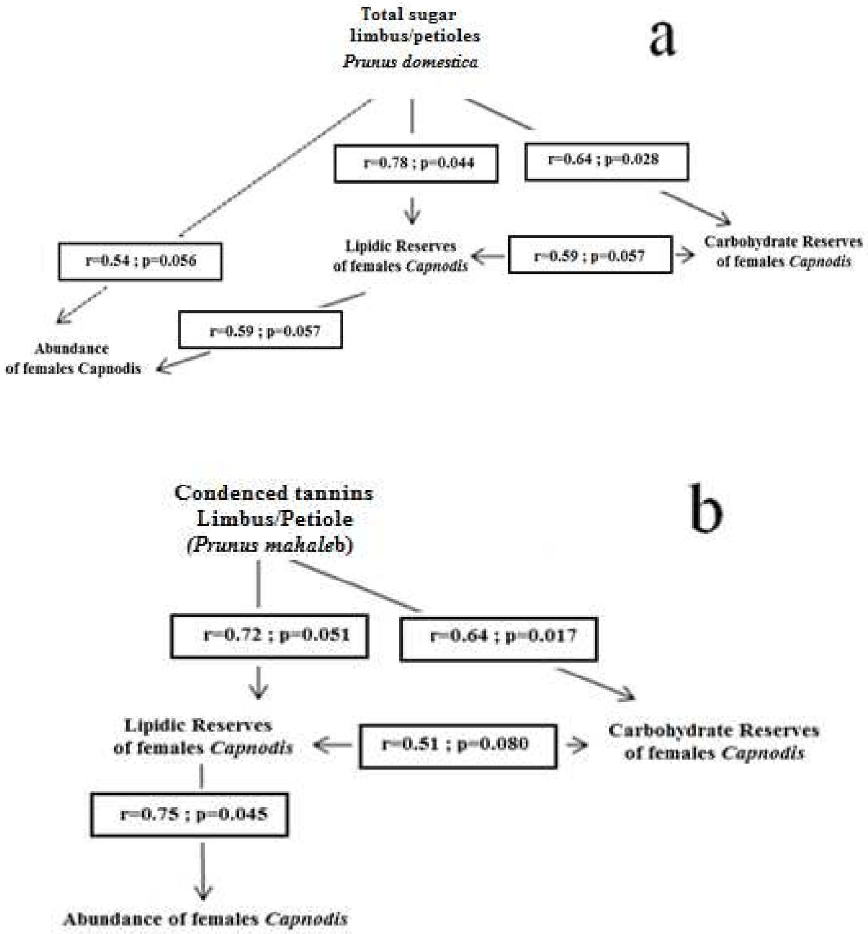


Figure 5: Recapitulative Diagram of Link between Phytochemical Quality of Host Plant and Capnodis Female's Energetic Parameters

Relative diagram for the purpose of *Prunus domestica* on *Capnodis* females' energetic allotment (Figure 5a) allows establishing multitude relations between different variables. It is emerging that total sugars of petioles and limbus are positively correlated on the one hand, to lipidic-carbohydrate reserves with pronounced affinity to carbohydrate reserves. On the other hand; they are marginally correlated to *Capnodis* female's abundance. Although energetic reserves express links enough interesting, we have to signal individualized effect of reserves lipidic on *Capnodis* female's abundance.

As for *Prunus mahaleb* effect on *Capnodis*' female's energetic allotments (Figure 5b) diagram brings out installation of new strategy implying revision of lipidic- carbohydrate reserves. In *Prunus mahaleb* condensed tannins of petioles and limbus are positively correlated to lipidic and carbohydrate reserves. In both cases, it is carbohydrate reserves

which relate affinity very marked to nourishing support. Following same tendencies, Capnodis' female's abundance is strongly correlated to lipidic reserves.

DISCUSSIONS

Characteristics living theory is searching to supply evolutive understanding to translate diversity and complexity of living cycle of a specie, to elucidate allotment mechanisms of resources intended for growth and reproducer maintenance (Barraut, 1984; Roff, 1992; Begon *et al*., 2006).

In particular, through this study, we have tempted to highlight, impact linked to diet' stress on *Capnodis tenebrionis'* females in energetic reserve matter, numerical and ponderal evolution of *Capnodis'* females differ very significantly in function of host's specie *Prunus domestica, Prunus mahaleb*).This talking is translated by Bauce *et al.* (2001), who finds that chemical substances contained in plants play important role in insect's evolution inside of its host. These same results perfectly explain those of Lagaude (1948), which produces decreasing classification of attacked trees by capnode established in Morocco, and which demonstrates that Japanese and common plum-tree with attack's 42% is presented as specie the most attacked followed by cherry-tree with rate of 34% and at last apricot-tree with 12%In their environment, phytophage insects are susceptible to meet during their existence, resources range of nutritive with very variable quality.

Their preferences are explained by presence of chemical compounds in plant having attractive capacity or repulsive for devastating (Winks & Schimmer, 1999). Nutritive quality depends of contain in nutritive matter (nitrogen, sugars and water) and can be affected by substance allelochemical presence (phenols, terpene, etc). This variability in foliage nutritive quality between plants take over several factors, as species nature, This talking connect with upper concentrations in total sugars in *Prunus domestica* compared to *Prunus mahaleb*. Brewer *et al.* (1985), point out that soluble sugars are nutritive compounds which play primordial role in growth and development of phytophage insects. Sugar is recognized to increase weight of phytophage adults, and decrease development time (Harvey, 1974; Mclaughlin, 1986).

Capnode adults' development is closely linked of time; this result is remembering us talking of Hunter (1992), who finds that attack synchronisation in function of host's development plays key role in survival and in dynamic of some insects 'populations. In general, as growing season moves toward, as resource quality decreases (Hunter & Elkinto, 2000). This is explication about importance of *Capnodis* individuals abundance on *Prunus mahaleb* in spring period, and in summer period on *Prunus domestica*, taking advantage like this of fructification periods rich in nutritive compounds.

Numerical and ponderal success of capnode adults moved around on *Prunus domestica* is going in the same sense of obtained results by GLM who indicates significant deficit of lipidic reserves rate of capnode adults moving around on *Prunus mahaleb* compared to *Prunus domestica*. It is question of energetic biomarker installation, where quantity of available lipids for reserves seems to be the result of balance between food-taking and reserves demands by process as reproduction, maintenance and growing (BROWN *et al*., 2004), whereas in situation of *Prunus mahaleb*, individuals have at their disposal only limited energy quantity which should be allocated to growing at the expense of other functions (reproduction and maintenance).

Energetic reserves fluctuation is linked to variability of nutritive elements and compounds of defence under direct seasonal and climatic effect which are going to condition insect's biological cycle (Ristola *et al*., 1999) and are going to

adjust females' ecological optimum (Baier, 1996). During nutritional disequilibria, females may have ovarian regressions and then, a weak lying performance. This phenomenon goes to allow to *Capnodis* females to allocate its resources to their longevity while postponing their oviposition to a moment where conditions would be optimum (Baur *et al.*, 1998). In this way, nutritional quality less appreciable to *Prunus mahaleb*, delays in our opinion, adults development having higher energetic need and making worse by entrance of the last one in dormancy from mi-summer.

Adaptations in life history features allow so, to individuals to reply with best selective value terms to selection's pressings which they suffer in their habitat, that those pressings arise from used resources or from existing inter-specific interactions within of their community (Stearns, 1992; Futuyuma, 2001; Reznick & Travis, 2001). Stearns (1992) & Roff (1992), estimate that life history traits correspond to individuals characteristics of specie and to major events during their life which contributes to production and survival of descendants (reproduction system, mass at adult state and longevity).

From what it comes to be talked, we can say that life history traits of *Capnodis tenebrionis* are described further to established correlations and so, closely link showcase between Carbohydrate reserves and particularly lipidic and total sugars concentrations. This disposition is directly translated on *Capnodis* individuals which show themselves more abundant on *Prunus domestica.* Theory of life history features searches thus, to supply evolutive explanation to translate diversity and complexity of specie's life cycle to elucidate resources allotment mechanism intended to growth and maintenance of somatic functions with reproducer performances or "*reproduction effort*" (Levins, 1968 ; Barbault, 1984).

For long time, it is drawn up that facing to toxic substances present in the plant; insects developed various strategies of primary installation which go from storage to desintoxification of active principle. For that reason, important metabolic reactions will be placed in position to reduce or to avoid damages caused by host plant's metabolites. Those mechanisms cost in energy and in resources which provoke weaker availability to build energetic reserves (Brow *et al*., 2004), those effects seem to us interesting in the mind to translate significant difference of lipidic energetic reserves between both *Capnodis* females' hosts. It is important to point out those individuals which are moving around on *Prunus domestica,* instantaneously use surplus of total sugars available in food ration which allowing them so, to manage high quantities of condensed tannins ingested at the same time with saturant meal.

Instantaneous use of carbohydrate quantities ensures lipidic storage and detoxification of tannic complexes. This approach is going through observations of Martikainen & Rantalainen (1999), who think that facing stress (reserves insufficiency) individuals should do strategic choice in terms to orientate energetic result towards diet or realise another activity. This roused stress seems, to be not ignored in individuals moving around *Prunus mahaleb,* where weak quantities in condensed tannins would probably play role of gustative stimulator which would allow to *Capnodis'* females to satisfy their hunger with vegetable support with weak rate in total sugars, where divergence in *Capnodis*' individuals abundance. That goes at the same sense of existent correlations between tannins and different energetic reserves.

CONCLUSIONS

Host specie nature, adjusts significantly behaviour of *Capnodis tenebrionis'* females on diet and aggregative plan. Numerical success of capnode individuals on *Prunus domestica* appoints an attractive effect more important compared to *Prunus mahaleb* that means, performance nutritive is more important on *Prunus* domestica, and which is translated by ponderal success of adults moving around on the last one. It demonstrates like this, good energy's partition intended at one and the same time to reproduction and conditioning. This ponderal development is showed with more expressed manner

during reproducer developments stages which coincide with host plant's physiological activity pick. Capnode's adult's preference for *Prunus domestica* has not be discouraged by presence of concentrations more important in condensed tannins on *Prunus domestica* compared to *Prunus mahaleb.* This appetency not diverted for *Prunus* domestica must be explained by a good practicing management of energy balance.

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